Sauna bathing reduces the risk of venous thromboembolism: a prospective cohort study

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Abstract

Emerging evidence suggests there is an inverse and independent association between sauna bathing and arterial thrombotic disease. However, the potential association between sauna bathing and venous thromboembolism (VTE) has not yet been investigated. We aimed to assess the prospective association between frequency of sauna bathing and the risk of VTE. Baseline sauna bathing habits were assessed in 2,242 men aged 42-61 years without a history of VTE in the Kuopio Ischemic Heart Disease prospective cohort. Cox proportional hazards models were used to estimate hazard ratios (HRs) with 95% confidence intervals (CIs) for VTE. During a median follow-up of 24.9 years, 146 (6.5%) incident VTE events were recorded. In age-adjusted analyses, the HRs 95% (CIs) of VTE were 0.67 (0.47-0.96) and 0.95 (0.53-1.70) for participants who had 2-3 and ≥ 4 sauna sessions per week respectively compared with participants who had ≤ 1 sauna session per week. After further adjustment for several established risk factors including lifestyle factors, the corresponding HRs (95% CIs) were 0.67 (0.46 to 0.96) and 0.92 (0.51-1.68) respectively. Having sauna baths was associated with a reduced risk of VTE in a middle-aged male Caucasian population. Further studies in other populations and age groups are required to confirm these findings.

Keywords: sauna bathing; venous thromboembolism; cohort study

Introduction

Venous thromboembolism (VTE), which includes deep vein thrombosis (DVT) and its complication, pulmonary embolism (PE), is associated with reduced life expectancy and substantial healthcare costs.(1) Though substantial progress has been made in identifying risk factors for VTE with the availability of effective thromboprophylaxis, the occurrence of VTE is not on the decrease.(1) Venous thromboembolism is closely linked to atherosclerotic cardiovascular disease (CVD) (arterial thrombotic disease) (2, 3) and they share some common risk factors such as obesity, hypertension, diabetes mellitus, and adverse lipid levels.(4) Both disease states appear to share common pathophysiological mechanisms which include inflammation, endothelial dysfunction, coagulation and platelet activation.(5) Sauna bathing, a traditional Finnish activity that is mainly used for the purposes of relaxation and pleasure, has been consistently linked with a reduced risk of atherosclerotic CVD.(6) Plausible pathways proposed to underlie the protective effect of sauna exposure on cardiovascular outcomes include improvement in endothelial function(7) and reduction in inflammation(8) and lipids.(6) Given the close link between VTE and atherosclerotic CVD and the observation that sauna exposure exerts beneficial effects on factors implicated in the development of VTE, we hypothesized that sauna bathing may be linked to a reduced risk of VTE. In this context, we aimed to assess the association of frequency of sauna bathing with the risk of VTE, using a population-based prospective cohort of 2,242 middle-aged Caucasian men.

Methods

We employed the Kuopio Ischemic Heart Disease (KIHD) risk factor study, a general population-based prospective cohort study conducted in eastern Finland. The baseline sample comprised of 2,682 randomly selected middle-aged men aged 42-61 years, who had baseline measurements performed between March 1984 and December 1989. The study design, recruitment of participants and assessment of risk markers have been described in detail previously.(9) Prior to blood collection for measurements of circulating biomarkers, participants fasted overnight, were instructed to abstain from drinking alcohol for at least 3

days, and refrain from smoking for at least 12 hours. Baseline demographic and lifestyle characteristics, existing medical conditions, levels of physical activity, and socioeconomic status (SES) were assessed by self-administered questionnaires.(10) Baseline sauna bathing habits were also assessed by self-administered questionnaires which included assessment of the weekly frequency and duration of sauna sessions, and the temperature of the sauna bath during the exposure. The assessment represented an average sauna use during the week. Each questionnaire was cross-checked by an experienced nurse at the time of baseline examination.(10) The primary outcome included all first lifetime VTE events that occurred from study enrollment through to 2017. These were identified by computer linkage to the National Hospital Discharge Registry data and a comprehensive review of available hospital records. Positive imaging tests were used to confirm DVT or PE diagnoses. In the KIHD, participants are under annual continuous monitoring for deaths and incident events including VTE outcomes. For the current analysis, complete information on sauna bathing habits, relevant covariates, and VTE outcomes was available for 2,242 men. The research protocol was approved by the institutional review board of the University of Eastern Finland and all study procedures were conducted according to the Declaration of Helsinki. All study participants provided written informed consent. Cox proportional regression models were used to compute hazard ratios (HRs) (95% confidence intervals, CIs) for VTE after confirming the proportionality hazards assumptions. Participants were classified into three groups based on the frequency of sauna bathing ($\leq$1, 2-3 and $\geq$ 4 sessions per week).(10) Statistical analyses employed Stata version 15 (Stata Corp, College Station, Texas, USA).

Results

The overall mean (standard deviation, SD) age and BMI of study participants at baseline were 53 (5) years and 27 (4) kg/m^2 respectively. The median (interquartile range, IQR) frequency of sauna bathing was 2 (1-2) times per week. During a median (IQR) follow-up of 24.9 (18.1-27.0) years, 146 VTE cases (annual rate 2.72/1,000 person-years at risk; 95% CI: 2.35 to 3.25) occurred. A restricted cubic spline

showed there was a continuous association of frequency of sauna with risk of VTE, which was consistent with a curvilinear shape (*p* value for non-linearity=0.02). In age-adjusted analysis, when compared to participants who had ≤ 1 sauna session per week, the HRs of VTE were 0.67 (95% CI: 0.47 to 0.96) and 0.95 (95% CI: 0.53 to 1.70) for participants who had 2-3 and ≥ 4 sauna sessions per week respectively (**Table 1**). The corresponding HRs remained consistent following further adjustment for several other established risk factors: 0.67 (95% CI: 0.46 to 0.96) and for 0.92 (95% CI: 0.51 to 1.68) respectively.

Comment

Robust data from previous observational studies support an inverse and independent association between frequency of sauna bathing and arterial thrombotic disease.(6, 10, 11) To the best of our knowledge, this is the first study to examine the prospective association between the frequency of sauna bathing and risk of VTE in a general population-based cohort of middle-aged Caucasian men. We found evidence of a curvilinear shape to the association, with men who took 2-3 sauna sessions per week having a significant and greater risk reduction in VTE than those who took ≥ 4 sessions per week.

Factors implicated in the pathogenesis of VTE include inflammation, endothelial dysfunction, alterations in blood flow, immobilization, and hypercoagulable states.(12-14) The pathophysiological mechanisms underlying the association between sauna exposure and reduced VTE risk may relate to the ability of sauna exposure to (i) reduce systemic inflammation;(8) (ii) improve levels of potential VTE risk factors such as hypertension and lipids;(6) (iii) improve endothelial function;(7) and (iv) decrease viscosity of the blood by increasing plasma volume.(15) Sauna exposure increases the temperature of the body, improves circulation and activates vascular function, which could also lead to increased venous return and decrease VTE risk. The modest effect seen in the high frequency sauna group could be attributed to inadequate power to demonstrate an association given the low sample size and event rate in this group or may reflect an increase in plasma viscosity as a result of excessive loss of fluids.

The current findings add to the growing evidence that sauna bathing has beneficial effects on adverse vascular outcomes. Sauna bathing may represent an important approach for VTE prevention, but further studies are needed to confirm these findings in other populations and determine the optimal frequency and duration of sauna sessions needed for VTE prevention.

Strengths of this evaluation include the novelty, the large sample size and prospective cohort design, the representativeness of the sample in the general population, the long-term follow-up, and analyses which took into account a comprehensive panel of established and emerging VTE risk factors. The limitations included the potential for misclassification of sauna assessment because it was questionnaire-based, inability to account for sauna habits which may have changed over the years of follow-up, findings based on middle-aged men, outcome data based on only total VTE events which precluded the ability to evaluate specific VTE outcomes (DVT or PE), and the relatively low VTE event rate.

In conclusion, frequency of sauna bathing was associated with a reduced risk of VTE in a middle-aged Caucasian population and this was independent of several established and emerging risk factors. Further studies in other populations and age groups are required to confirm these findings.

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Conflict of interest

The authors declare they have no conflict of interest.

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Table 1. Association of frequency of sauna bathing and risk of venous thromboembolism

Frequency of sauna bathing (sessions/week)	Events/ Total	Model 1		Model 2	
		HR (95% CI)	*P*-value	HR (95% CI)	*P*-value
≤ 1	45 / 587	ref		ref	
2-3	86 / 1,460	0.67 (0.47 to 0.96)	0.031	0.67 (0.46 to 0.96)	0.029
≥ 4	15 / 195	0.95 (0.53 to 1.70)	0.850	0.92 (0.51 to 1.68)	0.792

CI, confidence interval; HR, hazard ratio; ref, reference

Model 1: Adjusted for age

Model 2: Model 1 plus body mass index, systolic blood pressure, prevalent coronary heart disease, smoking status, history of diabetes, total cholesterol, lipid medication, total physical activity, alcohol consumption, socioeconomic status, prevalent cancer, and high sensitivity C-reactive protein